DOCUMENT RESUME

ED 466 154		IR 021 224
AUTHOR	Dlodlo, Nomusa; Dlodlo, Joseph B.; Masiye, Bighton S.	
TITLE	Agent-Based Workflow Systems in Electronic Distance Education.	
PUB DATE	2001-06-00	
NOTE	8p.; In: ED-MEDIA 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications. Proceedings (13th, Tampere, Finland, June 25-30, 2001); see IR 021 194.	
PUB TYPE	Reports - Descriptive (141) -- Speeches/Meeting Papers (150)	
EDRS PRICE	MF01/PC01 Plus Postage.	
DESCRIPTORS	*Computer Mediated Communication; Computer Networks; *Computer System Design; *Distance Education; Educational Development; Foreign Countries; Higher Education; *Intelligent Tutoring Systems; Internet; Nontraditional Education	
IDENTIFIERS	Zimbabwe	

ABSTRACT

Current workflow systems largely assume a closed network where all the software is available on a homogenous platform and all participants are locally linked together at the same time. The field of Electronic Distance Education (EDE) on the other hand, requires the next-generation workflow that will integrate workflows from a distributed heterogeneous environment in order to support students who are not only dispersed over a wide geographic area but are working at different times. The notion of agents, particularly mobile agents, provides an elegant way of executing workflow processes across geographic borders. This paper looks at integrating agents into the current workflow systems that support distance education in order to create a theory for the design of intelligent workflow systems. This will enable an active collaborative work among participants who subscribe to EDE. (Contains 12 references.) (Author)

AGENT-BASED WORKFLOW SYSTEMS IN ELECTRONIC DISTANCE EDUCATION

Nomusa Dlodlo, Joseph B. Dlodlo *, Brighton S.Masiye #
National University of Science and Technology
Box AC 939
Bulawayo
Zimbabwe
Tel: +263-9-229 425 / 265
Fax: + 263-9-76804
E-mail: ndlodlo@hotmail.com
*Email: jbdlodlo@yahoo.com
#E-mail: masiyebs@hotmail.com

Abstract

Current workflow systems largely assume a closed network where all the software is available on a homogeneous platform and all participants are locally linked together at the same time. The field of Electronic Distance Education (EDE) on the other hand requires the next-generation workflow that will integrate workflows from a distributed heterogeneous environment in order to support students who are not only dispersed over a wide geographic area but are working at different times. The notion of agents, particularly mobile agents provides an elegant way of executing workflow processes across geographic borders. This paper looks at integrating agents into the current workflow systems that support distance education in order to create a theory for the design of intelligent workflow systems. This will enable an active collaborative work among participants who subscribe to EDE.

Introduction

The Internet has accelerated the development of electronic distance education (EDE) as a medium for providing efficient global communication. At present numerous virtual universities have sprung up. However, none of these sites is totally automated as human intervention is required for routines such as exchange and assessment of course work. The teacher makes no provision for the student to initiate submission of course material. Almost equally passive is the teacher's action. Here the teacher sends the student course material and waits for the student to reply via e-mail. There is no automatic notification of the tutor once the coursework arrives on his machine. A push strategy is required to speed up submission of course work by the student and quick response on evaluation from the tutor.

Neither EDE nor the Internet respect artificial boundaries and the teacher and student may be situated at many different locations spread across the world. A worldwide audience of students is able to benefit from one specialist in a particular field through subscribing to EDE. The quest for higher education will see a lot of movement towards EDE. Therefore methods have to be used to ensure efficient student –lecturer interaction in an EDE environment. The other reason why there is need for efficient EDE implementations stems from the poor data communication infrastructure installed in most developing countries. This infrastructure was meant to support voice traffic rather than data. The bandwidth is generally limited leading to reduced performance. The result has been increased timeouts as students try to download their courseware. In most cases the bandwidth is limited to 64k putting a strain on the system and in some cases resulting in congestion. The use of automated systems will result in reduction of congestion in the network. Data can be cleared pretty fast due to the use of agents which are employed in the routing process. The longer the data stays in the system the higher the loading of the system.

It is inevitable that EDE systems will use different software and hardware platforms. To support such a heterogeneous environment, EDE software must be able to execute uniformly, unaffected by the platform on which it is executing. Automated mechanisms are needed to cut across the different virtual environments.

In education, just like in many business applications decision-time is a crucial factor that provides a cutting edge over competitors. Reduction in interaction time through automation in education requires close coordination between the tutor and student. But more EDE applications still involve a substantial human element, which in turn limits the speed at which interaction occurs. Consequently a major objective of EDE research is a reduction in human involvement in the intermediate stages of course delivery. An EDE system should therefore support the ability to embed intelligence in the system, to automate strategic decision-making that was traditionally performed by humans. Moreover the decision-making capability provided should be dynamic, reacting to user needs and the current environment.

Typical course offerings over the Internet require many interactions, each of which must be communicated over the Internet, which is much faster than prior human-to-human communication but relatively slow compared with the computers that the Internet interconnects. An EDE system that can perform interactions locally without repeated Internet communication will achieve significant performance over prior approaches. To satisfy these requirements for an EDE system, mobile agent technology emerges as an appropriate technology. This technology allows an agent in the form of program code, data and execution state to be packaged into a message and sent across the Internet to remote computers. The mobile agent can execute on remote computer, and only bring back the results to .

In the educational marketplace, many suppliers adopt a push strategy to announce their coursework and conduct surveys of student response to the quality of the coursework. Traditionally this has been done by humans, who visit the student on behalf of the tutor. With appropriate automation, mobile software agents can be sent to many student sites, quickly and with low cost, obviating human involvement in the educational process. Mobile agents can be used as student assessors to determine the quality of education. In the past this would have been achieved by querying many students individually in a student survey, analysing the response, and determining the optimum quality of teaching and to maximise the student. With mobile agents these calculations can be done dynamically at student sites, to determine the student response and quality of courseware and to adjust the courseware accordingly. The objective of the mobile agent technology is to maximise the returns of the courseware.

Workflow automation is emerging as the most rapid, cost-effective enabler of change even in EDE. It allows organisations to become more adaptable by continuously customising their work processes. Workflow automation achieves this through intelligent applications of codified business rules, processes and best practices, and by automatically providing the right individual with timely access to relevant information. It allows employees to perform their jobs more efficiently and cost-effectively. Workflow automation in conjuction with agent technology will improve the efficiency of EDE-related workflows.

2. What is workflow automation?

Workflow automation is the automation of business processes, in whole or in part, during which information of any type is passed to the right participant at the right time according to a set of intelligent business rules [White, 2000]. This allows computers to perform most of the work while humans have only to deal with the exceptions. At its most basic level, workflow is the passing of documents, information or tasks from one participant to another, or from one application to another. Workflow automation has the potential to deliver the following benefits:

- Improved productivity
- Reduced operating and labour costs
- Improved customer service
- Increased sales
- Reduced waste and duplication

- Improved access to timely information
- Minimal IT and job-specific training

Routing, rule enforcement, role/relationship definition and tracking/auditing are essential characteristics of workflow systems. Routing involves transferring information from one defined person or automated process to another. For example, data from the fixed format part of a Web questionnaire might be routed to another program for analysis, while data from a "comments" section on the same questionnaire might be routed to a human being for review. Rule enforcement is a defined procedure that determines the action taken when a particular information task is received. A rule might state, for example, "If a sale decreases inventory to a certain level, then launch a new work task to restock that item."

Role/relationship definition is a group of one or more people in a workflow environment who share common responsibilities [Workflow, 2000]. For example, "authorized virtual university student" could refer to any one of several individuals who might fulfil that role. Data in a workflow system is often routed to an individual by virtue of their authority to serve in a specific role. The assignment of a specific person to take on the role is based on who is available when and where a particular task needs to be done. Tracking/Auditing is the ability to readily find out where a particular task is and where it has been already. This capability is often missing from the processes that automated workflow systems are intended to replace, i.e. the old "it must be lost in somebody's inbox" problem. Questions such as "has the course material been delivered to the authorised student', and "has the right course material been delivered" are answered by this.

Workflow systems can be classified as image-based, form-based and co-ordination-based [Workflow,2000]. Image-based workflow systems are designed to automate the flow of paper through an organisation, by transferring paper to digital images. These are used in EDE to transfer documents between the student and the lecturer. These were the first workflow systems that gained wide acceptance. Form-based workflow systems are designed to intelligently route forms throughout an organisation. These forms, unlike images, are text-based and consist of editable fields. Forms are automatically routed according to the information entered on the form. In addition these form-based systems can automatically remind people when action is due. They can be used be the tutor to alert students when the coursework is due. This can provide a high-level of capability than image-based workflow systems. Form-routing systems vary from traditional vertical market workflow systems, like those used for insurance claims processing, to the recent crop of products that handle general administrative tasks like travel expense reimbursements across many types of businesses. Coordination-based workflow systems are designed to facilitate the completion of work by providing a framework for coordination of action. The framework is aimed to address the domain of human concerns (business processes), rather than the optimisation of information or material processes. Such systems have the potential to improve organisational productivity by addressing the issues necessary for customer satisfaction, rather than automating procedures that are not closely related to customer satisfaction. They are useful in defining the sequence of course modules in EDE.

Workflow systems can also be classified as queue-centred systems, ad-hoc systems and collaborative systems. Perhaps the most familiar queue-centred system comes in the form of telephone interactive menu systems, where you wait till a person is available to handle your request. In distance education the student sends in their assignment and wait for the teacher to reply. These systems can be more complex when they provide, for example, elaborate workflow handling for exceptions, or serve as a front end feeding into other workflow systems. Ad hoc systems mimic what was once done in face-to-face meetings and phone calls. They typically exploit the ability of "GroupWare" software and modern email systems to handle routing slips, voting, etc. Circulating resumes or getting approval of minutes are two examples of how such systems are used. This form of workflow is also finding application in distance learning where it can be used to simulate traditional classroom interaction. Collaborative routing systems are appropriate workflow tool in a regulatory approval process, for example, where circulating drafts are to be reviewed and revised until they are rejected or approved for handoff to the next system. These systems may handle both highly structured data typical of "forms routing" systems as well as less formal data characteristic of ad hoc systems.

Agents in conjunction with workflow automation offers a chance to improve the efficiency of EDE-related workflows.

3. What is an agent?

An agent is a simple heterogeneous autonomous communicating software component. Autonomous agents are able to work on behalf of the user without the need for any interaction or input from the user. They act without human intervention, tirelessly performing tasks. Some of these systems scour the world's databases, usually via the WWW or other generic access methods returning interesting and relevant information such as the literature recommended by the tutor.

Intelligent agents are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in so doing employ some knowledge or representation of the user's goal or desires. A typical example might be an information-gathering agents. Agents operate without the direct intervention of humans or others and have some kind of control over their actions and internal states. Many agents are meant to be used as intelligent electronic gophers - automated errand boys. Tell them what you want them to do - search the Internet for information on a topic, or assemble and order course material according to your desired specification - and they will do it and let you know when they are finished.

The typical client/server architecture communicates via requests and responses, which require a round trip trek across the network. Often the client and server pieces are on separate machines and they communicate over the network. When the client needs data or access to resources that the server provides, the client sends a request to the server over the network. The server in turn sends a response to the request. This 'handshake" occurs again and again in a traditional client/server architecture.

In mobile agent architecture, the client actually migrates to the server to make a request directly rather than over the network. When the client in the mobile agent architecture needs data access to a resource that the server provides, the client does not talk to the server over the network. Instead the client actually migrates to the server's machine. Once on the server's machine, the client makes its request to the server directly. When the transaction is complete, the mobile agent returns home with the results.

Mobile agents solve the client/server network bandwidth problem such as that arising in EDE as a result of the poor communications infrastructure versus efficient student-tutor interaction. Network bandwidth in a distributed application is a valuable and sometimes scarce resource. A transaction or query between a client and a server may require many round trips over the wire to complete. Each trip creates a network traffic and consumes bandwidth. In a system with many clients and/or many transactions, the total bandwidth requirements may exceed available bandwidth, resulting in poor performance for the application as a whole. Mobile agent architectures also solve the problems created by the intermittent or unreliable network connections. Agents can be built quite easily that work "off-line" and communicate their results back when the application is "online".

A mobile agent is an entity composed of two different pieces. One piece is the code itself, which consists of the instructions that define the behaviour of the agent. The second piece is the current state of execution of the agent. Often these pieces are separate. For example, in a typical computer program, the code sits on the disk while the executing state sits in RAM. A mobile agent however, brings the two together. When an agent migrates to a new host, both its code and its state are transferred.

If the state monopolises telecommunications, there are no controls to the prices that they will charge for accessing the Internet. The problem is even compound in Africa because of the few telephone lines, which exist. (Cohen, 199) puts it this way: "A few statistics illustrate why the basic requirements of access-a-telephone-line presents problems for less industrialized countries. Globally, 49 countries, 35 of which are in Africa, have less than one telephone per 100 people". The lack of telephone lines in some areas makes it difficult to cultivate an Internet culture, as there is need for a telephone line and a computer in order to be able to gain access to the Internet.

Besides not having reliable telephone lines which are necessary for usage of the Internet, cost is also inhibitor to Internet access. (Guinness, 1999) states that access is:

...typically at around US$3 for half an hour...Equipment prices are [also] high once you move north of South Africa. Add up to a third once you hit Namibia or Botswana, more as you reach Zimbabwe and northwards. In one very typical African country, even a modest secondhand PC can cost at least $1,000- the price of a new machine in America. And signing up to an ISP [Internet Service Provider] could cost $130 a month.

Some governments at times tries to regulate the content of the information accessed over the Internet. According to (Cohen, 1999), this happens in countries where telecommunications are monopolized by the state. Governments can also restrict access for political purposes and economic gain. (Cohen, 1999) further observes: *"Globally, some governments have chosen to control the liberalising effect of the Internet by denying access to entire segments of their populations, either through exorbitant charges or by confining access to select groups".*

4. The link between agents and workflow in EDE

The concept of an agent, in particular that of a mobile agent which travels around the network on behalf of its owner has gained significant interest in various areas of computation such as Artificial Intelligence, distributed computing and communications [Chang, 2000].

Workflow processes are associated with these agents. For example, a typical organisation usually has its own workflow process defining business activities and overall control flow of work. It seems reasonable to assume that mobile agents in a collaborative environment should have process information embedded within them in order to find a target destination once an activity has been initiated. Additionally a mobile agent must know the various characteristics of the actual roles involved with workflow processes. For example, a mobile agent at a project leader's machine may have all the access priviledges to a deliverable schedule, while a mobile agent at a programmer's may not. Obviously, this difference is not bound to an actual machine but by the roles participants play. Infact, if a programmer is allowed to act as a project leader, (perhaps because the project leader is sick), a mobile agent must change its characteristics dynamically in order to avoid any disruptions in the workflow process.

Virtual universities are a natural application area for image-based workflow systems, since they still process enormous amounts of paper work. Virtual universities can adopt workflow for the routing and control of documents in the form of images between tutor and student. It is almost impossible to make use of imaged documents without implementing workflow software at the same time. Workflow is viewed as primarily a means for tracking and controlling documents. The five benefits for adopting workflow systems are the following. There is faster processing of work, since the total transaction time is generally much greater than the time to complete the work steps. Workflow systems are usually based on the client-server architecture, as opposed to mainframes. The information processes of the "work flows" are made explicit and are more easily changed. The amount of paper used is reduced. eliminated. Financial losses from misprocessed paper are also eliminated.

Workflows in EDE involve the following procedures:

- Rapid information dissemination of coursework from the tutor to the student
- Submission of assignments to the tutor by the students in the shortest possible time
- Efficient feedback mechanism on submitted assignment from the tutor to the student.
- Evaluation of the quality of coursework by student for the tutor
- Authentication of access to resources by students who subscribes to a particular university
- Collaboration with other virtual institutions on exchange of course material
- Connecting students who subscribe from other virtual institutions
- Search for literature across the Internet/Intranet /Extranet as advised by the tutor.
- Scheduling of courses
- Computer conferencing hours between the tutor and student.
- Scheduling of examinations
- Tutoring

4.1 Student assignments

In traditional paper-based distance education, course material follows a sequential route through the tutor, post office and student. In contrast companies employing workflow utilise imaging systems to manage information. The course material is entered into a computer system. With a few strokes information is routed, tracked, stored and managed by mobile agents. Students in different geographic regions can simultaneously access the material, perform their assignment, and send it back to the tutor. No multiple copies of a document are needed in order for the different students to work on it. At the stroke of a button the coursework is sent back to the tutor.

4.2 Authentication of students

Depending on the structure of the virtual university, if the courses are available over the Internet, then there is free access for all to the course material. But where an Intranet/Extranet exists access to courseware is controlled. For example, where an Extranet exists, the virtual organisation mails the password to the subscriber, and where an Intranet is concerned only the staff and students can have access to the password that allows them to access the resources. Agents can come in at several points. There can be an agent to direct a student with a particular password to the appropriate resources. Another agent to trace a product, i.e. that student X has not been sent the same assignment twice.

The agent should incorporate features that ensure minimum delay in transfers. The agent should monitor the routing options and select the most optimum route. The agent can enforce security by preventing unauthorized access to the data itself by other users of system other than the recipients. This agent should be able to determine multiple retransmissions and therefore block retransmission of same data. Systems without agents suffer service degrading due to too much traffic load.

4.3 Search for literature across the Internet/Intranet /Extranet as advised by the tutor

The sheer quantity of information accessible through the Internet poses the question of where to start searching for prescribed literature and where to go next. Another problem is that the networkable capabilities of many current systems mean that the data to be examined may exist on many different machines in a variety of forms. This means that a variety of access protocols have to be used in order to obtain the data in the first place, and then it has to be converted into a suitable format for integration with other data sets currently under investigation. The problem of searching for data is suited to an agent-based approach. Setting the agents off and allowing them to integrate data sets from different databases across the world requires autonomy and asynchrony [Beale, 1994].

4.4 Scheduling courses and exams

Having a desktop agent that can manage your time and scheduling of multiple courses is an example of a local application that is suited to agent-based interaction. This task is inherently difficult due to the problem of trying to satisfy multiple sets of time constraints, and due to the asynchronous nature of the information transfer between geographically separate users. Each user has to have an agent that is able to communicate with other agents.

4.5 Tutoring

The heart of tutoring is an intelligent agent. This agent imbeds sufficient knowledge of a particular topic area to provide "ideal" answers to questions. The Intelligent Tutoring System [McAuthur] can monitor the student as he/she solves algebraic problems and can determine every step in the right direction. Tutoring agents are entities whose ultimate purpose is to communicate with the student in order to efficiently fulfil their respective tutoring function, as part of the pedagogical mission of the system [Mitsuru, 1997]. So, educational applications, in general, are based on Tutor and Mentor agents.

4.6 Assesment of student work and quality of courseware

Pedagogical agents have a set of normative teaching goals and plans for achieving these goals (e.g., teaching strategies), and associated resources in the learning environment [Thalmannn, 1997]. The utility driven agents (e.g. Web agents) are used by pedagogical purpose like reminding the deadline of homework.

Conclusion

Workflow systems for EDE need to combine flexibility with optimisation. Agent technology offers mechanisms for such. They support not only local but decentralised, distributed and flexible workflow through asynchronous communication. This research looked at the integration of agents into EDE workflow systems, and how this integration improves the efficiency of these workflow systems.

References

[Beale, 1994] Beale., Wood., "agent-based Interaction", HCI'94, Glasgow, 1994, pp. 239-245

[Chang, 2000] Chang, J.W., Scott, C. T., "agent-based workflow: TRP Support Environment (TSE). Computer Networks and ISDN systems, vol. 28, issues 7-11

[Eisenger, 1992] Eisenger, N., Elshiewy, N., "MADMAN - Multi-Agent Diary Manager", ESRC-92-7I Internal Report

[Foner, 1993] Foner, L., "What's an agent anyway?" - A sociological Case Study, MIT Press

Giraffa, L.M.M., Vicarri, R.M., "The use of agents techniques on intelligent tutoring systems", Informatics institute, CBL, Leeds University.

McAuthur, D., Lewis, M., Bishay, M., "the role of Artificial Intelligence in education', RAND Coorporation, Santa Monica, California

[Sculley, 1992] Sculley, J., "Odyssey: Pepsi to Apple", Fontana/Collins, pp.540-565, 1992

[White, 2000] "A white paper by the Workflow Automation Corporation"

[Wordperfect, 1993] Wordperfect Cooperation, 1993

[Workflow, 2000] http://cne.gmu.edu/modules/workflow/workflow-into.html

Thalmann,D.; Noser,H.; Huang,Z. Autonomous Virtual Actors Based on Virtual Sensors. In: Creating Personalities for Synthetic Actors: towards autonomous personality agents. Trappel,R.; Petta,P. (Eds.). Berlin: Springer Verlag, 1997.

Mitsuru,I. Etalii. Opportunistic Group Formation. AI-ED97 : Eighth World Conference on Artificial Intelligence in Education - Workshop V : Pedagogical Agents, 8.,1997. Proceedings. Kobe: Japan, 1997.

NOTICE

Reproduction Basis

- [x] This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

- [ ] This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").